Growing field beans in Canada

Agriculture Canada

Publication 1787/E

Canada

Agriculture Canada Publication 1787/E
available from
Communications Branch, Agriculture Canada
Ottawa K1A 0C7

Cat. No. A53-1787/1985E ISBN: 0-662-13769-8
Printed 1985 Reprinted 1989 3M-7:89

Également disponible en français sous le titre
Les haricots de grande culture au Canada.

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Recommendations for pesticide use in this publication are intended as guidelines only. Any application of a pesticide must be in accordance with directions printed on the product label of that pesticide as prescribed under the *Pest Control Products Act*. **Always read the label.** A registered pesticide should also be recommended by provincial authorities. Because recommendations for use may vary from province to province, your provincial agricultural representative should be consulted for specific advice.

Growing field beans in Canada

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INTRODUCTION

Field beans or dry edible beans are an important commercial crop in some parts of Canada. They are also grown in home gardens throughout the country. Ever since field beans were first introduced in Ontario as a commercial crop in the mid-1800's, production has increased steadily. Production has exceeded home consumption since the 1930's. White beans (pea beans or navy beans) have become an important export commodity, the greater portion of the trade being with Britain. Recently, colored beans have become a significant part of the trade with Latin American countries. The field bean industry in Canada is worth over $60 million per year. In 1981, over 100 000 tonnes of dry beans were produced on 53 000 ha. Ontario produces about 80% of the total Canadian production of both white and colored beans. In Alberta and Manitoba, the hectarage of field beans has steadily increased in recent years.

The field bean is a leguminous crop that belongs to the same species (*Phaseolus vulgaris*) as the snap bean. Lima beans, scarlet runner beans, azuki beans, and mung beans are closely related species and, in the broad sense, are grouped as field beans. However, this manual deals only with common field beans.

The edible part of the bean is a true seed, which is a mature fertilized ovule developed into embryo and endosperm. Germination is epigeal (above the surface of the ground) with the cotyledon and shoot pushing through the soil. Field beans are a warm-season annual with different cultivars growing 25–60 cm tall, with erect bushes (determinate growth type), vines (indeterminate), or prostrate (indeterminate) habits of growth. Field beans have a taproot and they fix nitrogen in root nodules. The leaves are pinnately trifoliated. The pealike flowers may be white, pink, or purple and are borne in clusters (racemes) on peduncles. The flowers are self-pollinated before they open. The pods contain a varying number of seeds, depending on the cultivar and the type. The size and color of the seeds vary greatly.

Field beans marketed as dry beans are used almost entirely for human food. Dry beans are an important source of nutrients because they contain about 22–24% protein and are a good source of minerals and vitamins. Beans are eaten mainly as canned food such as pork and beans and in salads and soups. On a smaller scale, dry beans are marketed in packets for home preparation. Canadians eat an average of about 3.5 kg of dry beans every year.

TYPES OF BEANS AND THEIR MAIN CULTIVARS

Field bean cultivars are of many types (market classes), as listed in Table 1. The agronomic characteristics of representative cultivars and their response to some diseases are summarized in Table 1. Cultivars differ greatly in size, shape, and shade and pattern of color of beans (Fig. 1). Cultivars for dry bean production differ from those used for vegetables such as snap beans.

Pea beans (navy or white beans)

Pea beans are the predominant type grown in Ontario and are used mainly for canning as pork and beans, soup, and various home cooking uses. Pea beans are chalky white, round to ovoid in shape, and weigh 17–21 g per 100 seeds.

The current cultivars grown are Sanilac, Seafarer, Kentwood, Ex Rico 23, and Fleetwood and all are bush types. In 1983, four new cultivars, OAC Seaforth, Harokent, Harofleet, and OAC Rico, with improved disease resistance to anthracnose races alpha, beta, gamma, delta, epsilon, and lambda, and also to common bean mosaic virus (CBMV) races 1 and 15, were developed by the backcross method and released jointly (by the Agriculture Canada Research Station at Harrow and the University of Guelph) as replacements for the original varieties.

OAC Seaforth is an early bush type with white flowers. It matures about 2 days later than its recurrent parent, Seafarer, but its yield and cooking quality are similar to Seafarer. It is susceptible to bronzing caused by ozone and to seed discoloration mainly caused by *Alternaria* spp. Because of its earliness and good yield, it is expected to be accepted as widely as Seafarer.

Harokent is a medium season bush type with white flowers. Its maturity and cooking quality are about the same as its recurrent parent, Kentwood, but its yield is slightly less (3%). The seeds are slightly larger than other pea bean varieties.

Harofleet is a full season bush type with white flowers. In Ontario, it matures about a week later than Kentwood and 10 days later than OAC Seaforth. It is about 2 days later than its recurrent parent, Fleetwood, but its bean yield and quality are similar.

OAC Rico is a full season bush type with white flowers. Plants tend to spread more than Harokent and have guides (short runners). It matures about 4 days later than Harokent and 2 days earlier than Harofleet. Most of its flowers are borne under the leaf canopy. It is tolerant of white mold, but susceptible to bronzing.

Kidney beans

Kidney beans have large kidney-shaped seeds that weigh 55–63 g per 100 seeds. There are three main classes of kidney beans: light red (LRK), dark red (DRK), and white (WK) depending on the color of the seed coat. Red kidney beans are used for chili con carne, baking, and salads, and white kidney beans are used for baked beans. The LRK beans are grown most widely, and the WK beans are a minor class in production. The WK beans tend to be more easily discolored when harvest is delayed in wet weather. No cultivars of kidney beans are licensed in

Canada at present. Some U.S. cultivars are grown using seed imported from either California or Idaho.

Charlevoix (DRK) is an early maturing bush type with purple flowers. It is resistant to alpha and beta races of anthracnose. It is tolerant of rust and air pollution. It was released by Michigan State University (MSU).

Montcalm (DRK) is a medium maturing erect bush type with white flowers. Unlike Charlevoix, it is resistant to both halo blight and CBMV races 1 and 15. It was released by MSU in 1974.

California (DRK) is a late maturing full season bush type with white flowers. It is susceptible to anthracnose, CBMV, and halo and common blights. It is resistant to mechanical impact injury. It was released by the University of California at Davis.

Manitou (LRK) is a full season maturing bush type with purple flowers. It is resistant to alpha and beta races of anthracnose. It is susceptible to CBMV and halo blight. It was released by MSU.

Mecosta (LRK) is a full season maturing bush type with white flowers. It is resistant to the alpha race of anthracnose, CBMV, and halo blight. It was released by MSU.

Redkloud (LRK) is an early maturing bush type with white flowers. It is resistant to halo blight and susceptible to mechanical damage. It was released by Cornell University.

Sacramento (LRK) is an earlier maturing bush type with purple flowers. It is susceptible to most diseases. It was released by the University of California at Davis.

Other red kidney bean cultivars are Red Kote (LRK, medium maturity, Cornell University, New York), California (LRK, late), Royal Red (DRK, late, Washington State), and Ruddy (LRK, early, Cornell University, New York State).

Black beans

The size and shape of black bean seeds are similar to those of pea beans. The seed coats are black and the flowers are purple. Many cultivars have an erect viny growth habit. This type of bean is produced mostly under contract for the export market. Such beans are often used to prepare black bean soup or fried beans.

Black Turtle Soup (BTS) is a mid- to full season erect vine type. It is tolerant of halo blight and bronzing and susceptible to anthracnose and CBMV. It is an introduction from Venezuela that was released by Cornell University. It is also called common black bean in Manitoba.

T39 is a mid- to full season cultivar selected from BTS. It is resistant to CBMV and rust. It was released by the University of California at Davis.

Loop is a mid- to full season bush type. It was selected from common black beans by the Manitoba Pool Elevators, a farmers' cooperative system, and licensed in 1981.

Other black bean cultivars are Midnight (late maturity, Cornell University), Domino and Black Magic (late, MSU), and Ebony and Black Beauty (privately bred cultivars).

Table 1. Agronomic characteristics and response to diseases of commonly grown field bean cultivars

Type	Cultivar	Maturity	Growth habit	Flower color	Halo blight	CBMV*		Anthracnose				Root rot	Pollution	Curly top
						1	15	α	β	γ	δ			
Pea beans	Seafarer	E	B	W	R	R	R	R	R	R	S	S	S	
	Sanilac	M	B	W	R	R	S	R	R	R	S	S	S	
	Kentwood	M	B	W	R	R	S	R	R	S	S	S	S	
	Fleetwood	F	B	W	R	R	R	R	R	R	S	S	S	
	Ex Rico 23	F	B	W	S	R	R	S	R	S	S	S	S	
	OAC Seaforth	E	B	W	R	R	R	R	R	R	R	S	S	
	Harokent	M	B	W	R	R	R	R	R	R	R	S	S	
	Harofleet	F	B	W	R	R	R	R	R	R	R	S	T	
	OAC Rico	F	B	W	S	R	R	R	R	R	R	S	S	
Light red kidney	Mecosta	F	B	W	R	R	R	R	S	S	S	S	T	
	Manitou	F	B	P	S	S	R	R	R	S	S		T	
	Sacramento	E	B	P	S	S	S	S	S	S	S		T	
	Redkloud	E	B	W	R	R	R/S	R	S	S	S			
Dark red kidney	Charlevoix	M	B	P	S	S	R	R	R	S	S			
	California	F	B	P	S	S	S	R	S	S	S			
	Montcalm	M	B	W	R	R	R	R	S	S	S		T	
Black bean	Black Turtle Soup	F	SV	P	T	R	R	S	S	R	S			
	T39	F	SV	P	T	R	R	S	S	R	S			
	Midnight	F	USV	P	T	R	R	S	R	R	R			
	Loop	F	SV	P	T									
Cranberry	Michigan Improved Cranberry	M	B	P	S	S	S	R	S	S	S		T	
	Taylor Cranberry	M	B	P	S	S	S	R	S	S	S			

Pinto	UI 111	E	V	W	R	R	S	R	R	S	S				
	UI 114	M	V	W	R	R	R	R	R	S	S				
Red	UI 36	M	V	W	S	R	R	R	R	R	R				R
	UI 37	E	V	W	S	R	R	R	R	R	R				R
	Rufus	F	V	W	R	R	R	S	S	S	S	T			
Pink	Viva	EM	V	W	S	R	R	R	R	S	S	T			
Yellow eye	Steuben	F	V	W	R	S	S	S	S	S	S		T		
Great northern	UI 59	M/L	V	W		R	R								S
	GN 1140	E/M	V	W		R	R								S
	GN Star	E/M	V	W											
	GN Harris	M/L	V	W											

All cultivars are susceptible to common blight except GN Star and GN Harris, which are tolerant.
Maturity = E (early), M (medium), F (full season), L (late).
Flower color = W (white), P (pink or purple).
Disease = S (susceptible), R (resistant), T (tolerant).
Growth habit = B (bush), V (viny), SV (semiviny), USV (upright semiviny).

* CBMV = Common bean mosaic virus, races 1 and 15.

Fig. 1. Field beans are classified into various types (market classes), based on size, shape, and shade and pattern of color of beans. From left to right:
Top row: OAC Seaforth, Harokent, Harofleet, Steuben yellow eye
Second row: small white pea bean, pinto, red Mexican, pink
Third row: dark red kidney, light red kidney, white kidney, small white
Fourth row: great northern, cranberry, black, white marrow
Fifth row: Jacob's cattle, brown, light brown, snap bean type

Cranberry beans

Cranberry beans have medium to large seeds that weigh 50–57 g per 100 seeds. The seeds are light pink to variegated red on a buff background. Some cultivars of this type are Michigan Improved Cranberry (medium maturity, viny, MSU), Taylor Cranberry (early, bush, privately bred cultivar), and Cranberry UI 50 and UI 51 (medium, bush, University of Idaho, UI). These beans are used mainly to prepare Italian bean soup.

Pinto beans

Most cultivars of pinto beans are early to medium maturing, semitrailing vine types, and are resistant to halo blight, curly top, and races 1 and 15 of CBMV but susceptible to rust. The seeds weigh about 33–37 g per 100 seeds, and are medium in size, short and broad, somewhat flat, with round-square ends. Seeds have a brown variegated pattern on a light tan background, and a white hilum bordered by a narrow, distinct yellow ring. These beans are used mainly for baking and chili con carne. No varieties are licensed in Canada at present.

UI 111 is an early maturing, viny type with white flowers. It was released by UI in 1945.

UI 114 is a medium maturing, viny type with white flowers. It yields better than UI 111. It was released by UI in 1965.

Other pinto cultivars are Ouray and Olathe (medium maturity, Colorado State), Pindak (medium maturity, North Dakota State), Fiesta and Gala (medium to early maturity, Idaho Seed Bean Co.), and Columbia (medium maturity, USDA, Prosser, Washington).

Red beans (red Mexican or small red)

Seeds of red beans are dark red, medium in size, and weigh about 32–35 g per 100 seeds. The growth habit is semiviny but more upright than pinto and great northern types. Red beans are generally more susceptible to seed cracks, therefore they must be harvested and handled carefully. Red beans have a sweet flavor and a mealy texture and are used in Mexican and Spanish dishes with chili powder.

UI 36 and UI 37 have medium and early maturity, respectively, with a large vine and white flowers. Both are resistant to CBMV, anthracnose, and curly top, but are susceptible to halo blight. UI 37 yields less than UI 36 because of its earliness. It was released by UI in 1964.

Other cultivars of red beans include Rufus, NW 63, and NW 59, which require a full season to mature. These beans were released by USDA, Prosser, Washington.

Pink beans

Pink beans are mostly semiviny, have indeterminate growth habit with early to medium maturity, but are not as viny as pinto and great northern cultivars. The

seeds are pinkish, with shape and size similar to small red beans, that is, 100 seeds weigh about 33–36 g. Pink beans are tolerant of seed split. Pink beans are used for making bean soup and for cooking with chili powder.

Sutter Pink has medium maturity with white flowers. It is tolerant of fusarium root rot, susceptible to most diseases, and very susceptible to rust. It was released by the University of California at Davis.

Viva Pink has medium maturity with white flowers. It is resistant to CBMV, tolerant of fusarium root rot, and very susceptible to rust. It was released by USDA, Prosser, Washington, in 1974.

Other pink varieties are Rosa and Gloria. They have medium maturity and are resistant to CBMV. They were released by USDA, Prosser, Washington.

Yellow eye beans

Yellow eye beans have medium to large oval-shaped seeds with a yellow pigment around the hilum. The weight of 100 seeds is about 40–50 g. These are specialty beans for canning and baking, especially with molasses. All cultivars are susceptible to anthracnose and CBMV.

Steuben requires the full season to reach maturity. It has a short vine. It is tolerant of ozone damage. It is a selection from New York yellow eye beans released by Cornell University.

Kenearly matures a few days earlier than other varieties. It is a bush type. It was selected from a commercial yellow eye bean at Kentville Research Station, Nova Scotia.

Great northern beans (large white)

The great northern beans have mostly late maturity and are indeterminate viny types with a prostrate growth habit. Flowers are white. Seeds are medium-sized, weighing about 34–38 g per 100 seeds and are slightly flat, somewhat kidney shaped with white seed coats. These beans are commonly used in Italian cooking and are popular for baked bean dishes.

GN UI 59 is a medium-maturing selection from the old Great Northern variety. GN 1140 is a few days earlier than GN UI 59. Both are resistant to CBMV races 1 and 15, but are quite susceptible to common blight and curly top. The seed coat of GN UI 59 has good resistance to cracking and splitting during combining, but GN 1140 does not. Both of these varieties were released by the UI.

GN Emerson is a bright white, large-seeded, bacterial-wilt tolerant variety. It has medium maturity similar to GN UI 59 and has a viny growth habit. It was released by the Nebraska Agricultural Experiment Station in 1971.

GN Star is as early as GN 1140, with suitable seed size and shape. GN Harris is an early maturing, higher yielding bulk selection from GN Valley. These cultivars have tolerance for common blight derived from GN Nebraska #1. Both cultivars were released by the University of Nebraska, GN Star in 1976 and GN Harris in 1980.

SELECTING A CULTIVAR

Select a cultivar that will produce the maximum yield of high quality beans in your particular area. Selection depends largely on maturity, disease resistance and tolerance, standability, and adaptability to local cultural practices such as row spacing, rotation, weed control, and harvesting methods.

Beans are quite sensitive to temperature and soil moisture. They grow successfully only when the season is long enough to permit planting in a warm soil for quick germination and establishment of a stand, and harvesting before the first killing frost in the fall. If a cultivar is too early for an area, usually yield is less because it does not make full use of the growing season.

Consider the main disease problems in your area, and select resistant cultivars, if they are available. Tolerance for injury caused by air pollutants such as ozone (bronzing) and sulfur dioxide is important to consider in some areas close to urban industries. Lodging resistance and erect plant type, and resistance to cracking and splitting of beans by mechanical impact are also important factors in maintaining high-quality beans after combining and handling.

A list of cultivars would be out of date in a few years because new improved cultivars are released frequently. Check the crop production guide and the recommended varieties for your area and consult with a crop specialist or marketing board. If field beans are just being introduced into your area, try cultivars on the basis of test information available in the area and determine the cultivar best suited to your farm.

Field beans are grown in various regions across Canada. Types and varieties differ in each region because of different market demands and growing conditions.

In the Maritime Provinces, beans are grown on many farms for home use. Very few farmers produce them as a commercial crop. Therefore, no cultivars are listed in the field crop recommendations. In a survey in 1982, a range of 20–80 ha of various types of field beans were grown in each of the provinces. Cultivars Charlevoix and Redkloud (LRK) were grown in the vicinity of Bedeque, Prince Edward Island; Soldier in western New Brunswick; and Kenearly, Soldier, and Jacob's Cattle in King, Annapolis, and Digby counties in Nova Scotia. The survey indicated that the major problems of growing beans in this region are the short growing season; harvesting, drying, and processing the beans; and the short supply of clean seed.

In Quebec, commercial production of beans is limited to the vicinity of Montreal. According to a survey in 1982, Fleetwood (a pea bean), Sacramento (LRK), and cranberry beans were grown in the Richelieu county area. Total beans grown were on less than 400 ha in 1981. Of course, small areas of beans are grown throughout much of the province for home consumption.

Pea beans are the principal type of bean grown in southwestern Ontario. About 40 000 ha of beans are produced in Huron, Perth, Middlesex, and Lambton counties. Only a small amount of yellow eye beans are produced. About 12 000–16 000 ha have been devoted to colored beans. Major colored types are light and dark red kidney beans. Some minor colored types are black, pinto, red, cranberry, and white kidney beans. All the colored beans are grown under contract as specialty beans (see *Ontario Ministry of Agriculture and Food* Publication 296).

In the Prairie Provinces, Manitoba and Alberta produce dry beans commercially and there have been steady increases of hectarages in recent years. Beans produced in this region are mostly early maturing cultivars. In Manitoba, an early pea bean cultivar Seafarer and a new black bean cultivar Loop are recommended for southwestern parts of the province; small plantings are located around the Carberry area and larger ones around the Portage and Carman–Morden areas (see *Field Crop Recommendations for Manitoba* by Manitoba Agriculture). About 7800 ha of land were devoted to bean production in the province in 1981. The major types of beans are pea beans, pinto, and black beans, and the minor colored bean types are red Mexican, pink, great northern, and DRK beans.

In Saskatchewan, very few beans are grown commercially. According to a survey in 1982, about 200 ha of beans, mostly pinto UI 111, were grown in the vicinity of Outlook.

In Alberta, about 3400 ha of bean production are centered mainly in the Bow Island–Grassy Lake areas. The bean types mostly grown in the province are pinto (30–40%), pink (20–25%), great northern (10–18%), red Mexican (15–20%), and pea beans (10–15%). The principal cultivars are UI 111 (pinto), GN 1140 (great northern), UI 36 and Rufus (red), and Viva (pink), and Seafarer and Sanilac (pea beans) (see *Agdex* 142/204, Alberta Agriculture).

In British Columbia there is no commercial production of beans. Cultivar trials at the Agassiz Research Station have shown good yield with cultivars maturing in 105–110 days. On Vancouver Island, all cultivars matured and yields were satisfactory.

FIELD

Climate and soil requirements

Field beans require a warm growing season, and most cultivars need about 90–120 days to mature. The optimum temperature for beans is in the range of 18–23°C. The crop can tolerate a minimum temperature of 10°C and a maximum of 35°C for a short period. If temperatures below 8°C persist for a few days, flower abortions may result. However, dry hot wind with day temperatures exceeding 35°C can cause blossom drop and pod abortion. Prolonged cool wet conditions in the spring will make seedlings weak and easily susceptible to damping-off. Also, similar conditions in the fall will cause delayed maturity of beans. Usually bean production is more successful in areas where rainfall is light during the later part of the growing season. Good moisture throughout the period of growth and dry weather during harvest favor high-quality crops.

Field beans grow in a wide range of soil from sandy loam to clay loam. However, they grow best in a light- to medium-textured soil with high organic matter, good moisture storage, and good drainage. Beans are susceptible to poor drainage and soil compaction, because they are sensitive to oxygen deficiency. The most favorable soil pH for beans is between 6.5 and 7.0; when pH is below 6.0 or above 7.5, micronutrient availability may be affected. Beans do not tolerate saline soil.

Rotation

Field beans fit well in a rotation system. Beans are commonly grown following alfalfa, clover, cereal, corn, or sugar beets (in Western Canada). Beans are sensitive to residues of the herbicide atrazine, so they should not follow atrazine-treated corn. Generally, a rotation where beans are grown not more than once in 3–5 years is recommended. Although rotation may not completely eliminate diseases such as white mold and root rots, it can lessen the impact of these diseases. Avoid crops that have diseases in common with beans such as soybeans, lentils, peas, faba beans, sunflower, mustard, and canola. That is, these crops should not be used as a break crop in a rotation with field beans. High yields are usually obtained when beans follow a well-manured, legume sod. An alternative would be to plant beans following corn or small grains that have been seeded to a clover – green-manure crop.

Fertilizer

Optimum field bean production requires high fertility soil. In general, there are about 200 kg of essential elements contained in the tops of a 1000 kg navy bean crop. These are made up of 30% nitrogen, 24% phosphate, 17% potassium, 22% calcium, 6% magnesium, and 1% other.

Fertilizer requirements should be determined from a soil test. The soil test recommendation provides an estimate of the fertilizer needs (other than nitrogen) before planting the crop. If soil test results are not available, follow the general recommendations offered by the provincial crop committee or by the staff of the research station in your area. Also, however, plant analysis can be used to detect problems during the growing season and to evaluate the effectiveness of the fertilizer program. Plant analysis is a particularly useful tool for diagnosing deficiency symptoms of unknown elements.

Nitrogen (N) fertilizer usually is not required for field beans. The root nodules of field beans fix N at least as efficiently as those of soybeans. A starter application of N at 10 kg/ha is advisable for soils of medium-to-low fertility in Ontario. The N may increase the availability of the phosphate in banded fertilizer. In Alberta, N at 25–35 kg/ha has been satisfactory for soils with a medium level of N. Where bean yields have been low due to bronzing or root rots, additional N may be applied before planting to offset effects of these diseases. For instance, N at about 90 kg/ha is recommended for this purpose in Ontario.

In general, sandy soils have higher nutrient requirements than loamy soils, particularly for potassium. When manure is applied or if beans follow a legume sod, less fertilizer is required. Excessive use of fertilizer is wasteful and may have an adverse affect: for instance, excessive N delays maturity and makes plants more susceptible to diseases and insects. Excessive phosphate may induce immobility of minor elements such as zinc.

Do not place fertilizer in contact with the seed. The fertilizer may be broadcast and either plowed down or worked into the soil before planting. If fertilizer is applied at planting time, place it 5 cm to the side and 5 cm below the level of the seed by using separate boxes and shoes on the planter.

Deficiencies of minor elements may occur often in certain areas. For instance, zinc (Zn) deficiency has been observed in southern Alberta, where the soil pH is higher than 7.0. Zn is most available in slightly acid soil (pH 6.0–6.8) but is least available at pH above 7.4. Cool wet weather in the spring or early summer aggravates the problem. Plants may recover with warm weather if Zn deficiency is slight. Pea beans are known to be more sensitive than colored beans. Among pea beans the cultivar Sanilac is more susceptible to Zn deficiency than Saginaw. Zn deficiency can be corrected by foliar spray application in the form of zinc sulfate or a chelate, because soil applications are not effective.

Manganese (Mn) deficiency is often found in southwestern Ontario. Mn is most available below pH 6.0 and least available above pH 6.7. Correction of Mn deficiency should be done by the application of foliar spray of either manganese sulfate or a chelate.

In Manitoba, sulfur (S) at 20 kg/ha is recommended on well-drained sandy soil and Gray Luvisol (Gray Wooded) soil in order to maximize bean yields.

PREPARING THE SEEDBED

A seedbed should provide the best possible conditions for seed to germinate and emerge rapidly in order to establish a uniform stand of seedlings. The bed should be level and firm. The soil should be warm and have a good moisture supply at the depth of seed placement.

The time and type of tillage differs, depending on the soil type. If there is no risk of soil erosion, fall plowing is usually practiced for fine-textured heavy soil or for sod or heavy stubble on light soils. If soil is subject to erosion, provide a winter cover crop of a small grain such as rye or a fall-seeded clover. In Eastern Canada, fall plowing of clay soil is favored over spring plowing because it conserves soil moisture, and the freezing-thawing action during winter improves soil tilth.

Light sandy soils are usually plowed in the spring, as soon as the land can be worked. Spring plowing is also advisable to reduce the period of exposure when there is a high risk of soil erosion, as on sloping land or in windy areas. If land is plowed in the fall, delay spring tillage until just before planting to conserve moisture and provide a more mellow seedbed. Heavy clay soil particularly must be tilled at the right moisture condition to avoid producing a cloddy seedbed that dries out quickly and results in uneven seed germination. Compacted, wet soil tends to warm up slowly and to delay seed germination and emergence. In southern Alberta, the initial seedbed preparation often includes furrowing for irrigation purposes and to establish ridges for sowing the seed. Ridges, which are built up during cultivation, help warm the seedbed and make harvesting easier.

The need for further tillage after plowing depends on the soil type and the previous crop. You can disk, harrow, or cultivate the soil to break up large clods, to incorporate a herbicide, and to level the seedbed. Till only enough to obtain the desired seedbed.

PLANTING THE SEED

Selecting the seed

The use of high-quality, disease-free, pure seed is essential for starting a bean crop. Seed-borne diseases such as common bacterial blight (all bean cultivars are susceptible), halo blight (most of the colored bean cultivars are susceptible), and common bean mosaic virus cause losses if contaminated seeds are planted. Pedigreed seed is seed that has passed inspection for freedom from diseases, for cultivar purity, and for germination. For colored bean types, use seed increased in Idaho or California to avoid bacterial diseases. The extra cost of this seed is a wise investment.

Seed treatment and inoculation

Treatment of seed with a fungicide and insecticides ensures better germination, seedling emergence, and a more uniform stand. If the soil is cool and either wet or extremely dry, seedling emergence is usually delayed and seed is often subjected to damping-off fungi during prolonged periods of such conditions. Field bean seed should be treated with a fungicide and insecticides to protect it from microorganisms and insects. One insecticide is needed to control seed maggots, another is used to control wireworms, and a fungicide is applied to protect the seed from decaying and damping-off.

Insecticides applied alone may reduce germination, but in conjunction with a fungicide will protect the seed from the phytotoxic effects of the insecticides. However, do not treat beans with insecticides more than 3 months before planting. Drill-box formulation of insecticide-fungicide mixtures are available and should be used if seed has not already been treated. Always follow the instructions on the label when treating seed with pesticides. For your own protection while mixing them, use rubber gloves and a wooden paddle and do not breathe the dust.

Recommendations for inoculation with N-fixing *Rhizobia* vary from province to province. In Ontario, inoculation is not usually recommended because nodule-forming bacteria are already present in the soils in the main bean-producing areas. However, inoculation is advisable for land where field beans have not been grown previously. In Alberta and Manitoba, inoculation with the proper *Rhizobium* is recommended for all bean fields. Various forms of inoculants are available: powder forms with a sticker to ensure an adequate level of inoculants on seed and granular forms, which can be applied to the soil at the time of seeding (see *Field Crop Recommendations* by Manitoba Agriculture and *Agdex* 142/20-4 by Alberta Agriculture).

Time, depth, and rate of seeding and row width

Seed beans when the soil temperature at seeding depth has reached 10°C or higher and after all danger of frost is past. The seeding date will vary depending upon the type of soil, the place of beans in the rotation, the cultivar, the season, and

the probable weather at harvest time. Satisfactory seeding conditions occur in most areas between 15 May and 20 June. In Alberta and Saskatchewan planting begins in mid-May and it lasts for about a week. In Manitoba, planting begins around 20 May. In the Prairie Provinces, planting should be completed by 1 June. In Ontario, pea beans are planted between 20 May and 20 June in the central region and between 6 June and 20 June in the southwestern region. Kidney and other colored beans that are grown in the southwestern region are planted between 1 June and 10 June. In Quebec and the Maritime Provinces, beans are planted between 25 May and 10 June. Because planting dates vary considerably from one area to another, refer to crop production guides in your province or consult the research station in your area.

Plant beans just deep enough to cover them with soil and to provide contact with moisture for quick germination. Deep planting hinders the emergence of seedlings and increases the danger of seed decay and the risk of injury from seedcorn maggots. In coarse-textured soils such as sandy loam, beans may be planted about 7.5 cm deep to ensure placement in moist soil. However, planting in dry soil or planting deep to reach moisture is not recommended. If soil is too dry at planting depth, wait for rain rather than planting in dry soil. Crusting following a rain impedes seedling emergence when seed has been planted in dry soil. If a soil crust forms before emergence, a rotary hoe, pulled at a speed of 13–19 km/h, can be used to break up the crust. It should not seriously reduce the effectiveness of most preemergence and preplant herbicides.

Recommended planting depth varies slightly among provinces. In Ontario and all the eastern provinces, beans are planted 2.5–5 cm deep, whereas in the Prairie Provinces they are planted slightly deeper at 4–6 cm.

The seeding rate varies from province to province: from 40–45 kg/ha (or 15–20 seeds/m of row in 70 cm rows) for small-seeded types such as pea beans to 60–85 kg/ha (or 10–13 seeds/m of row in 70 cm rows) for kidney beans and other large colored bean types. Seeding rates can be varied within a limited range without affecting yield. The best way to establish the planting rate is to calibrate the planter or drill using the seed to be sown and drive at the speed that will be used. Plant at a reasonable speed, 4–5 km/h, to obtain accurate and uniform seeding.

Row widths can vary from 56 cm to 75 cm, with the 70 cm being the most commonly used. Rows wider than 70 cm produce lower yields of pea beans. Narrow rows (60 cm, 35 cm, or even 17.5 cm) appear to increase the yield of beans. Yield increases with narrow row spacing depend on the variety and the soil moisture at critical times such as at flowering and early pod-setting stages. Plant varieties that are adapted for narrow rows so that the beans can be combined directly. The width of row also depends upon the method of weed control planned. White mold can become a greater hazard in narrow rows.

CONTROLLING WEEDS

Cultural method

Till before planting to provide a weed-free seedbed. Once the crop has been planted, destroy young weeds with the use of a rotary hoe, a spike-tooth harrow, or a

finger weeder. Weeds are easily killed just as they are emerging (as white threadlike seedlings at or below the soil surface) through friable moist soil. To avoid breaking the bean hypocotyls and the spread of diseases, do not use the above-mentioned implements when the beans are just emerging or when the seedlings are wet. Use these implements during the hottest part of the day when the bean seedlings are dry and slightly wilted and when the weeds will dry quickly. Usually a stand loss of 10% is tolerable at this stage. Use these implements only on beans less than 10–15 cm high, and over that use a row cultivator.

Cultivation, in addition to controlling weeds, breaks the soil crust, aerates the soil, increases water infiltration, and facilitates harvesting by ridging the bean rows. Usually two or three cultivations are needed to control weeds between rows. Start cultivation at the second to third trifoliate leaf stage of the bean plants. Till for the second time about 3 wk later. Do not cultivate bean fields after plants have started to bloom or when plants are wet from dew or rain or when soil is wet. Root pruning is a major problem with cultivation. Pruning the secondary roots, which extend just below the soil surface at the beginning of flowering, is detrimental because it reduces the plant's capacity to absorb water and nutrients.

Hilling is accomplished by adjusting the cultivator for the last cultivation to leave a small depression between the rows and to place the soil next to the base of the stem. Hilling may help reduce root rot damage by causing new roots to be initiated further up the stem, which occurs more in light sandy loam soils than in the heavy clay soils. Hilling also helps in making furrows for furrow irrigation. If root rot is serious, cultivate shallowly, because diseased plants have limited root systems.

Chemical method

Herbicides can extend the period of weed control during the growing season and permit the use of narrow-row cultural practices. Herbicide selection depends on the weed species present, the uniformity of soil type, the amount of organic matter, and the method of application. Because some herbicides are more efficient in controlling grass weeds and others in controlling broadleaf weeds, consider the use of combinations of the two. Rotation of chemicals and cultural methods will prevent the buildup of specific weed problems. Control perennial weeds before they spread and become major problems.

The time and methods of application vary from chemical to chemical: some herbicides are applied before planting and are incorporated into soil by discing or by cultivating with an S-tine cultivator to mix the material well into the top 8–10 cm of soil (preplant incorporated), some are applied before emergence (pre-emergence), and some after emergence (postemergence). For details of current recommendations consult the guide to chemical weed control in your province (see *Guide to Chemical Weed Control,* Publication No. 75, by the Ontario Ministry of Agriculture and Food).

Mechanical cultivation used in conjunction with suitable herbicides is the best way to control weeds.

MANAGING WATER

Bean yields are often adversely affected by too much or too little water. When the soil pores are filled with an excessive amount of water, plants are stressed for lack of oxygen. When the soil is dry, plants suffer from lack of water. Both conditions often occur during the growing season in the eastern provinces: excess water in the spring and lack of moisture later in the season. In the Prairie Provinces, irrigation of dry, sandy soils is often needed.

Drainage

Pea beans are susceptible to poor soil drainage and lack of aeration at the prebloom stage. Yield may be reduced by half when the soil is flooded for 48 hours. Though flooding for only 24 hours at the prebloom stage appears to have little effect on yield, recurring oxygen stress (that is, flooding for 24 hours) significantly reduces yield. Heavy clay soils often have insufficient drainage. Improvement in drainage has a beneficial effect on bean yield as a result of the compound effects of increased aeration, increased availability of nutrients in soil, increased water-holding capacity, and higher soil temperature, which allows earlier planting, improved soil structure, and reductions in disease and weed problems.

There are two ways to improve drainage: by surface and by profile (tile) drainage. Improve surface drains so that they relieve accumulation of surface water. This type of drainage is important in fields having a slow infiltration rate due to soil compaction. Small depressions can also be corrected by moving soil with land levelers. The beneficial effect of tile drainage on crop yield is greater for beans than for alfalfa, sugar beet, wheat, corn, and oats. Proper drainage can improve yield by 50%.

Irrigation

The ideal soil for growing irrigated crops is one that rapidly absorbs water and then retains it for plant use. Sands, sandy loams, loams and organic soils usually have the capacity to rapidly receive water, but the lighter soils may not retain it well. Response to irrigation in the Prairie Provinces is not as great for field beans as for other crops. In southern Alberta, beans are usually irrigated twice in a growing season and up to four times on the lighter sandy soils. The critical time of irrigation is around the blooming and early pod development stages. To provide sufficient moisture in the seedbed, fall irrigation is also practiced. Use either the furrow or the sprinkler (or pivot) system of irrigation on beans. Stop irrigation before 10 August in southern Alberta to allow beans to reach proper uniform maturity. Frequent irrigation may lead to increased incidence of white mold disease in bean fields.

DISEASES

Beans are susceptible to many diseases. Some of the important diseases are listed in Table 2. Summaries of the major diseases and their controls are given

Table 2. Diseases of field beans and their control

Disease	Causal organism	Control measure: Rotation	Sanitation	Disease-free seed	Fungicide application	Seed treatment	Resistant variety
Diseases of underground parts							
Damping-off	Fungi					X	
Root rot	Fungi	(X)					(X)
Leaf diseases							
Anthracnose	Fungus		X	(X)			X
Common blight	Bacteria		X	X			(X)
Fuscous blight	Bacteria		X	X			(X)
Halo blight	Bacteria			X			X
Rust	Fungus	X			X		(X)
CBMV	Virus			X			X
BYMV	Virus						
TRSV	Virus						
Curly top	Virus						X
Stem diseases							
White mold	Fungus				X		(X)
Gray mold	Fungus				X		
Seed disease							
Alternaria	Fungus				X		
Nonparasitic diseases							
Bronzing	Ozone						(X)
Sunscald	Sunlight						
Heat injury	Sun-heat						
Baldhead	Seed injury						

X = control measure
(X) = limited control measure

below. For more details of these and other minor diseases, consult Agriculture Canada Publication 1758, *Bean diseases and their control* (1984) or *Agdex* 632-1 by Alberta Agriculture, *Diseases of pulse crops in Western Canada* (1981).

Seed rot and damping-off

Poor quality seed such as undersized, cracked or discolored seed may easily be subjected to infection by various types of soil-borne microorganisms under adverse soil conditions. A cool, wet seedbed provides favorable conditions for organisms to attack less vigorous and weak seedlings. Seeds may rot and seedlings may damp off, resulting in a poor stand of the bean crop. Causal organisms include commonly known fungi such as *Phythium*, *Rhizoctonia*, *Fusarium*, and *Phytophthora*. Often soil bacteria and other soil-borne fungi are also associated with this problem. The best control measures are to use seed that has been treated with a fungicide and to establish soil conditions that are favorable for seed germination and emergence of seedlings.

Root rot

When the soil is cool and wet, damping-off fungi are likely to attack the underground part of the plants. When the disease is advanced, the symptoms are reddish dark brown discoloration of roots and rotten pith of the stem. Infected plants show poor growth and their leaves turn light yellowish and often wilt under moisture stress later in the season. The disease probably causes more yield losses than any other bean disease. To combat the problems, use a rotation, till the soil to reduce soil compaction, and apply additional N. When resistant varieties become available commercially, they will provide the best control.

Anthracnose

Anthracnose was a serious seed-borne disease in the 1950's and early 1960's. It reappeared in the late 1970's with the presence of the delta race in Ontario. Anthracnose causes dark brown to black lesions along the underside of the veins of the leaves and on the leaf petioles, and rusty brown round lesions on the pods. Rainy, windy weather help spread the disease. Control the disease by growing resistant varieties. Other control measures include using disease-free seed, treating seed with a fungicide, rotating your crops, not cultivating field beans in wet weather, and keeping your field and equipment clean.

Bacterial diseases

Common and fuscous blights, caused by closely related bacteria, and halo blight are destructive diseases that attack leaves, pods, and seed. These seed-borne diseases reduce seed quality and yield.

Common and fuscous blights form on leaves as irregular brown lesions surrounded by a bright yellow border. In warm wet weather, the lesions coalesce

rapidly to produce large spots with a burned appearance. Infected pods have small brown lesions on them. The two types of blight are similar and cannot be distinguished by their symptoms alone.

Halo blight produces small, brown necrotic lesions surrounded by a halo of distinctive greenish yellow on the leaves; the small lesions may coalesce into larger ones. The disease develops faster under cooler temperatures early in the growing season; in the later stages, systemic chlorosis may extend to the entire plant. Round, reddish brown lesions develop on pods, which may result in seed infection.

Only a few great northern cultivars released by the Nebraska Agricultural Experiment Station are tolerant of common and fuscous blights. None of the other bean cultivars are tolerant of the blights. Most pea, black, and pinto beans are resistant to halo blight, but except for a few cultivars, kidney, cranberry, pink, and red Mexican beans are susceptible. Presently, the most effective control measure is to plant blight-free seed produced through the pedigreed seed multiplication system under rigorous inspection. Avoid working in the field when the leaves are wet so that you do not spread the disease if it should be present.

Virus diseases

Common bean mosaic virus (CBMV), bean yellow mosaic virus (BYMV), tobacco ring spot virus (TRSV), and curly top are the major virus diseases that attack field beans and occasionally affect yield. The diseases are transmitted by various means as shown below:

Disease	Vector or means of transmission
CBMV	Seed borne, insects (mainly aphids), pollen, mechanical
BYMV	Aphids, mechanical
TRSV	Nematode (*Xiphinema americanum*), mechanical
Curly top	Beet leafhopper

CBMV is the most common virus problem; races 1 and 15 are the most prevalent. Many pea bean and colored bean cultivars are resistant to either one or both races. Use virus-free seed and avoid planting beans close to vegetables or other crops such as sweet clover, red clover, crimson clover that are hosts of the aphid vector.

Black root is a hypersensitive reaction (a type of resistant symptom) to CBMV infection. Symptoms start with the sudden death of the growing point and a light to dark brown discoloration gradually extending downward to the leaf petioles, stem, and roots. Leaves of infected plants appear normal. Avoid planting seed of beans that carry the virus adjacent to resistant varieties that have the I gene.

TRSV causes necrosis and bud blight of white beans. Infected plants show systemic chlorotic spots and rings on the leaves and produce very few pods. No resistant variety is available yet, but a resistant source is known. Because it is transmitted by nematodes, avoid planting beans in fields with previous TRSV history. Also avoid spreading the virus by keeping tools and farm equipment clean.

Curly top is limited to areas where sugar beets are grown because of the presence of its vector, beet leafhoppers. Grow resistant varieties. Many pinto and red Mexican varieties and a few pea bean varieties are resistant. Follow local recommendations for planting early enough to escape the migration period of the vector.

Sclerotinia white mold

White mold is often a serious disease. Under warm humid microenvironmental conditions beneath the canopy, white cottony fungal masses are commonly found during August on the lower stem and on branches and pods lying on the ground. Black, oblong bodies (sclerotia) become embedded in the dead stems or cling to the side of the infected area. The sclerotia fall on the soil and become a persistent source of the soil-borne disease. The disease can be controlled by spraying with a fungicide, but for the most effective control, apply foliar sprays at first bloom, before the appearance of the disease. Ex Rico 23 and OAC Rico are more tolerant of the disease than other pea bean cultivars. Rotation is not an effective control method, especially in areas where the disease is widespread.

Rust

Rust occurs sporadically in bean fields and also tends to occur later in the season as the crop is maturing. Rust infection occurring within 3 weeks of maturity does not affect yield. Under favorable environmental conditions (a long period of continued leaf wetting from rain or dew and a temperature of 21–26°C), rust can develop rapidly and cause substantial reduction of bean yield due to premature leaf dropping. Pinto beans are highly susceptible and rust can be a serious problem with them. Avoid planting other bean crops next to pinto beans because a building up rust in the pintos can serve as inoculum for a rust problem in other beans. Control rusts by following a crop rotation of at least 2 years between bean crops, by plowing under all the bean refuse after harvest, and if necessary by dusting with finely ground sulfur.

Nonparasitic diseases

Bronzing is a physiological disorder caused by ozone damage. Ozone is generated by the interaction between sunlight (ultraviolet) and air pollutants. Ozone injury begins with purple reddish brown flecks on the upper leaf surface of the lower, older leaves. Later, the leaves become brown to red-bronzed in appearance. The bronzing develops very suddenly in hot, sunny conditions. Affected leaves drop off early and the whole plant ages prematurely. In severe

cases, losses in bean yield may be as high as 40%. Bronzing is commonly observed in mid- to late August in southwestern Ontario. Plants that are weak or under stress or both are more susceptible. No definite methods of control are known. However, some cultivars have more tolerance of ozone than others. Cultural practices that reduce root rot disease can reduce bronzing.

Sun scald is injury caused by intense sunlight following high humidity and cloudy weather. It affects leaves, stems, and pods. In Alberta, where bean fields are often irrigated, a rapid collapse of the entire plant without discoloration occurs under a period of high temperature accompanied by excessive irrigation. Sun scald does not usually affect bean yield.

Other nonparasitic disorders often observed in the bean field are baldhead, heat injury, and herbicide injury. Baldheads are caused by damaged seed during handling and threshing. Heat injury is caused by high daytime temperature, particularly in sandy soil. Herbicide injury may be caused by residual herbicides, such as atrazine from a previous corn crop, or by drift of 2,4-D, MCPA, and dicamba applied to nearby areas; field beans are highly sensitive to these herbicides, therefore proper precautions must be taken in their use; follow directions on the label.

CONTROLLING INSECTS

Insect pests have been a relatively minor problem in bean production in Canada. Insects can cause damage on both underground and foliage parts of the bean crop in the field and also in storage. The common insects of dry beans are listed in Table 3 along with possible control measures.

Most insects can be controlled effectively by use of the various recommended insecticides. In addition, damage can be reduced or avoided by using proper cultural practices. Crop rotation and soil types will strongly influence soil insects. Plow down and disc the crop residues because white grubs, wireworms, cutworms, slugs, and seedcorn maggots are especially common following sod, old pasture, or weeds. Adults (flies) of the seedcorn maggot are attracted to soil containing high organic matter, and seed treatment is essential to control the maggots. Beans should be planted away from alfalfa, which is a host of tarnished plant bugs and potato leafhoppers.

HARVESTING

When most (over 90%) of the leaves have fallen from the bean plants, and the stem and pods have lost their green color, the beans are ready for harvest. At this time, most of the pods are dry and the beans have hardened. Beans usually are harvested when seed moisture is 20% or less; the ideal moisture content is 18%. Chemical defoliants can be used to accelerate drying when the plants are approaching maturity. Defoliants do not speed up maturity, but they may reduce the time from maturity to harvest.

Bean harvest is usually a two-step operation—pulling and threshing (combining). First, bean plants are cut, or pulled, 2.5–5 cm below the ground with a bean puller, which places the plants from two rows into a puller row. In Ontario, a two-

Table 3. Insects and other pests of field beans and their control

Insects	Seed treatment	Insecticide spray or dust	Cultural practices	Remarks
Underground feeders				
Seedcorn maggots	X			Worse in organic soil
Wireworms	X		X	Worse following pasture
Cutworms		X	X	
White grubs (May beetles, June bugs)		X		Worse following pasture
Foliage feeders				
Sucking insects				
Potato leafhoppers		X	X	Builds up on alfalfa
Aphids		X		Vector for CBMV
Twospotted spider mites		X		
Tarnished plant bugs		X		Builds up on alfalfa; causes puncture marks on beans
Biting and chewing insects				
Mexican bean beetles		X	X	
Green cloverworms		X		
Grasshoppers		X		
Thrips		X		
Slugs		X		Not an insect; prevalent in pasture, sod
Seed insects				
Bean weevils		X		

X = control measure

row puller is used mostly in 60 cm or wider rows. In the Prairie Provinces, undercutting is done with a series of blades, usually 4-, 6-, or 8-row units, with each blade designed to cut one row. Later, two or more puller rows are windrowed together with a side delivery rake or a special windrower. The large windrow improves the efficiency of combining, removes soil and stones from the plants, and speeds up the drying of the vines. In the Prairie Provinces, usually 6–8 rows are pulled and windrowed together.

Bean plants should be pulled early in the morning, when the pods are damp and tough, in order to prevent losses from shattering. It is also important to keep the time between pulling and threshing as short as possible to avoid the chance of weather damage. However, in the Prairie Provinces, where the fall is dry, beans may be too dry for pulling at maturity without having losses from shattering. Therefore, plants may be pulled before they are fully ripe and laid in the puller row to dry for 1–2 weeks before they are windrowed and combined.

Most beans are threshed directly from the windrows by a combine equipped with a pickup attachment. Combines equipped with special options for pea beans or for large colored beans such as kidney beans are available from most farm machinery companies. The grain combine with spike-tooth cylinder usually causes less seed damage than rasp-bar types. Multiple-cylinder combines are also available for large colored beans like kidney beans for better quality of the threshed beans. Also, new rotary combines with proper adjustments thresh beans well with minimal seed cracking. A few adjustments on a combine have to be made for moisture content of the crop: cylinder speed and concave clearance. Cylinders should be run only fast enough to do a complete threshing job. Generally, cylinder speeds are set in a range of 200–400 rpm. Run as much volume of material as possible through the cylinder without overloading to help cushion the beans and minimize damage. Periodically check the combined beans and make minor adjustments in the operation of the combine during the day. Avoid combining mud balls (beans covered with mud) caused by wet harvest. Too many weeds and unripe, wet stems may result in green stained beans or higher moisture of the beans or both.

Direct combining is at the experimental stage. However, with improvements for plant type in cultivars and with adoption of flexible cutter-bars, direct combining may become possible.

Harvested beans that contain too much moisture (over 20–22%) will result in spoilage unless the beans are dried before storage. When the moisture content is 16–18%, beans will store safely for several months under cool conditions. For long-term storage, moisture content should be below 15%. High-moisture beans can be dried in most grain driers. However, seed beans should not be dried at temperatures exceeding 38°C.

Beans should be handled carefully to minimize damage (splits and cracks) to seed. If available, use a conveyor belt for loading and unloading beans, because augers will damage them. Avoid dropping beans from great heights and do not handle them when they are low in moisture or when the temperature is below freezing.

GRADING AND MARKETING

After beans have been combined, they are usually delivered in bulk to an elevator to be cleaned, picked, and graded.

Market grades for commercial beans are given in Table 4.

The sample of beans that you submit to the elevator are graded by an operator according to the content of foreign materials, stones, shale, or similar materials. They are also graded according to content of contrasting classes, damage, splits, other classes that blend, or for the combined content according to tolerance in grade definition. When a lot exceeds the limits specified for No. 4 Canada, it is graded Sample (class) account "reason" (for example, Sample pea beans, account heated, moldy, or odor).

Marketing of beans produced in Canada varies, depending on classes (types) of beans and province. In Ontario, white pea and yellow eye beans are marketed under the Ontario Bean Producers' Marketing Board. Since 1967, it has been an agency-type board that represents about 3000 growers. Agency marketing is a pooling arrangement that allows a producer to deliver beans to any dealer that is a recognized agent for the Board. The dealer makes an initial payment to the producer, based on No. 1 Canada grade beans and adjusted downward for moisture and picks, less the Board fee. Beans containing more than 18% moisture are discounted to allow for shrinkage and the cost of drying. Picks include beans that are large, immature, split, discolored, or diseased and materials such as stones and mud.

In Ontario, kidney beans and other colored beans are marketed differently from white and yellow eye beans. They are mainly grown under contract to local dealers. The market price is often arrived at before the crop is planted. The beans are sold on an 18% moisture basis and adjustments are made in the same way as for white beans.

In Alberta, various types of field beans are grown under contract with the Alberta Wheat Pool (Bean Plant). Similarly in Manitoba, a few classes of dry beans are grown under contract with local bean dealers.

PEDIGREED SEED

Pedigreed seed is seed granted a crop certificate by the Canadian Seed Growers' Association (CSGA), and graded and sealed under the provision of the Canada Seed Acts and Regulations. The purpose of seed certification is to maintain and distribute high-quality standard seed of licensed bean varieties, to maintain the identity of cultivars by maintaining purity, and to supply clean seed free from diseases. Impurity of a bean cultivar may result from the rare occurrence of outcrossing, mutation, or mechanical mixtures of offtypes while planting, harvesting, or processing the seed or both.

Once a cultivar of field bean is licensed, the breeder maintains Breeder seed as the nucleus for future pedigreed crop multiplication. Because of bacterial blight diseases, Breeder seed is increased in dry areas such as Idaho and California. From the Breeder stock seed, subsequent classes of pedigreed seed are multiplied. Select seed is grown from Breeder seed under strict supervision of CSGA. Foundation

Table 4. Grades* of beans in Canada of (A) the classes cranberry, black eye, and yellow eye, and (B) classes other than the classes in (A). (Canadian Grain Commission, Agriculture Canada, 1984)

Grade name	Standard of quality	Maximum limits (%) of											
		Foreign material (%)											
		Stones, shale, or similar material		Total foreign material		Contrasting classes of beans		Total including damage, foreign material, and contrasting classes		Total including splits, damage, foreign material, and contrasting classes		Other classes of beans that blend	
		A	B	A	B	A	B	A	B	A	B	A	B
Extra No. 1 Canada	Well screened and picked, uniform in size, of very good natural color	Free	Free	0.05	0.05	1	1	1	1	1	1	1	1
No. 1 Canada	Well screened and picked, of good natural color	0.05	0.05	0.1	0.1	1.5	1.5	1.5	1.5	3.5	2	3	3
No. 2 Canada	Reasonably well screened and picked, or reasonably good color	0.1	0.1	0.2	0.2	3	3	3	3	5.5	4	5	5
No. 3 Canada	Fairly well screened and picked, of fairly good color	0.2	0.2	0.5	0.5	5	5	5	5	7.5	6	10	10
No. 4 Canada	Off color	0.5	0.5	1	1	8.5	8.5	8.5	8.5	10	10	15	15
Final grade		Sample (class) account "reason"										Blend	

*The class name (cranberry, black eye, and yellow eye beans or pea beans, pinto, red, LRK, and DRK) is added to and becomes part of the grade name.

seed is multiplied from Select seed. Certified seed is grown from Foundation seed and is sold to commercial bean growers.

During the production of pedigreed seed, rigorous field inspection for varietal purity and diseases such as bacterial blight, anthracnose, and viruses are conducted by Agriculture Canada. Information on regulations and procedures of growing pedigreed seed can be obtained from the CSGA publication *Circular 6*. When a seed lot of a field bean cultivar is passed by field inspections and laboratory tests, a crop certificate is issued by the CSGA and the harvested seed is cleaned, graded, tagged, and sealed by Agriculture Canada. Only when it has been sealed and tagged, can seed be sold as pedigreed. The tags and seals are assurance of the Government of Canada and the CSGA that the seed is pedigreed, true to cultivar, and of high quality.

ACKNOWLEDGMENTS

The following scientists at the Harrow Research Station, Agriculture Canada, provided advice in their areas of expertise: A. S. Hamill, weed control; B. R. Buttery, physiology; R. I. Buzzell, breeding; B. N. Dhanvantari, pathology (bacterial diseases); W. I. Findlay, soil fertility; R. J. McClanahan, entomology; J. C. Tu, pathology (fungal and virus diseases). G. A. Kemp, field bean breeder, Lethbridge Research Station, Agriculture Canada, provided information on Western Canada.

CONVERSION FACTORS

Metric units	Approximate conversion factors	Results in:
LINEAR		
millimetre (mm)	x 0.04	inch
centimetre (cm)	x 0.39	inch
metre (m)	x 3.28	feet
kilometre (km)	x 0.62	mile
AREA		
square centimetre (cm^2)	x 0.15	square inch
square metre (m^2)	x 1.2	square yard
square kilometre (km^2)	x 0.39	square mile
hectare (ha)	x 2.5	acres
VOLUME		
cubic centimetre (cm^3)	x 0.06	cubic inch
cubic metre (m^3)	x 35.31	cubic feet
	x 1.31	cubic yard
CAPACITY		
litre (L)	x 0.035	cubic feet
hectolitre (hL)	x 22	gallons
	x 2.5	bushels
WEIGHT		
gram (g)	x 0.04	oz avdp
kilogram (kg)	x 2.2	lb avdp
tonne (t)	x 1.1	short ton
AGRICULTURAL		
litres per hectare (L/ha)	x 0.089	gallons per acre
	x 0.357	quarts per acre
	x 0.71	pints per acre
millilitres per hectare (mL/ha)	x 0.014	fl. oz per acre
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	lb per acre
grams per hectare (g/ha)	x 0.014	oz avdp per acre
plants per hectare (plants/ha)	x 0.405	plants per acre